Climate Change in New Jersey: Trends in Temperature and Sea Level

Background

A prediction of virtually all global climate models is that global temperature will increase as concentrations of greenhouse gases emitted due to human activity build in the atmosphere. As a result of this planetary warming trend, it is also predicted that sea level will rise. The global atmospheric concentration of carbon dioxide (CO_2), a major greenhouse gas, has risen about 35% since 1750, primarily due to anthropogenic emissions.[1]

Global average surface temperatures have risen by 0.6° C (1° F) during the 20th century, and CO_2 emissions due to human activity are projected to further raise global temperatures by 1.4° C to 5.8° C (2.5° F to 10.4° F) over the period 1990 to 2100. Global average sea level rose by between 0.1 and 0.2 meters (4 and 8 inches) during the twentieth century, and the global mean sea level is likely to rise by an additional 0.09 to 0.88 meters (4 inches to 35 inches) over the period 1990 to 2100.[2] Much of this rise is due to thermal expansion of the ocean and melting of land-based ice.

Other factors also can influence regional and local temperature and climate. One significant factor is increasing urbanization. The large expanses of asphalt and concrete associated with urban and suburban sprawl and the resulting decreased coverage of the land by forests, fields and other open space, are exerting a warming effect. This effect is especially pronounced in densely populated urban areas, which can exhibit what is called a heat island effect.

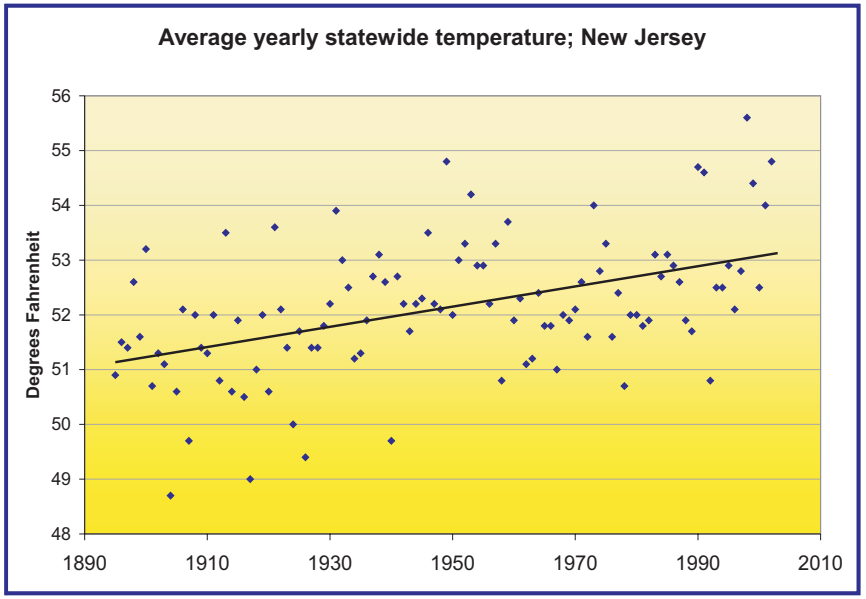
In New Jersey, long-term data document a significant increase in average temperature, and a significant rise in sea level that is consistent with observed and predicted global trends. In New Jersey, other factors also influence sea level, including subsidence of the land, which occurs for a variety of reasons.

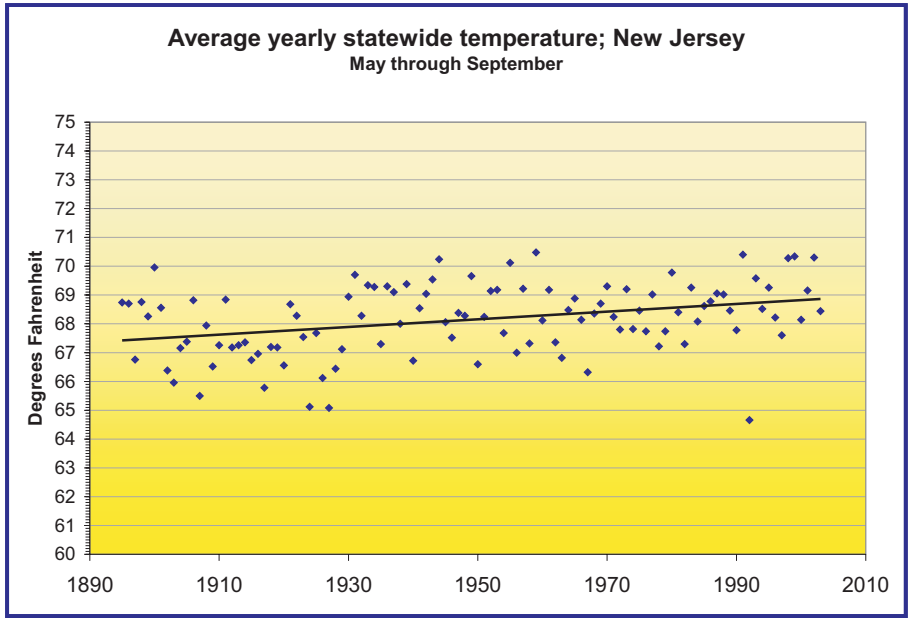
Status and Trends: Temperature

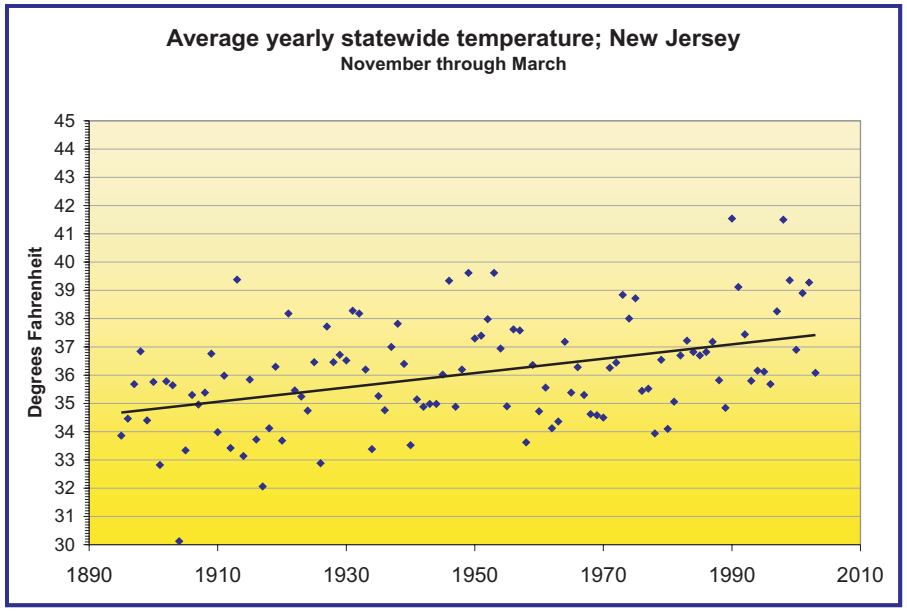
The Office of the New Jersey State Climatologist has gathered and quality-checked New Jersey statewide temperature records going back to 1895, and has made these data available on-line.[3] These data, as summarized and charted by the Department, show a statistically significant rise in average statewide temperature over the last 110 years.

Although there is much variation from year to year, overall both the normally cooler season (November through March) and the normally warmer season (May through September) are warmer now than formerly. The rise in temperature appears to be especially pronounced during the November through March period. See the three "Average yearly statewide temperature…" figures below.

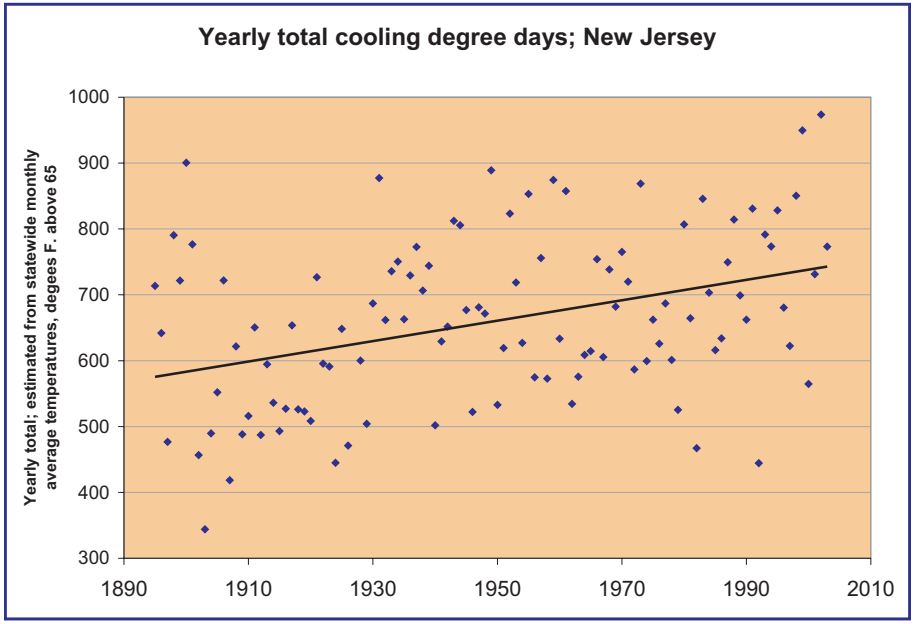
One important aspect of temperature is the effect it has on heating and cooling needs. This effect is often estimated by translating temperature readings into heating degree days or cooling degree days. Heating degree days are calculated as the difference between a day's average temperature and 65° F, if that day's average was below 65° F. Cooling degrees are the difference between a day's average temperature and 65° F if the average temperature was above 65° F.[4] More heating and cooling degree days generally translate to more energy expenditure for heating and cooling, respectively. However, other factors, such as the amount of insulation, the amount of space that is heated or cooled, and the efficiency of the heating or cooling equipment also play a role in heating and cooling energy requirements.

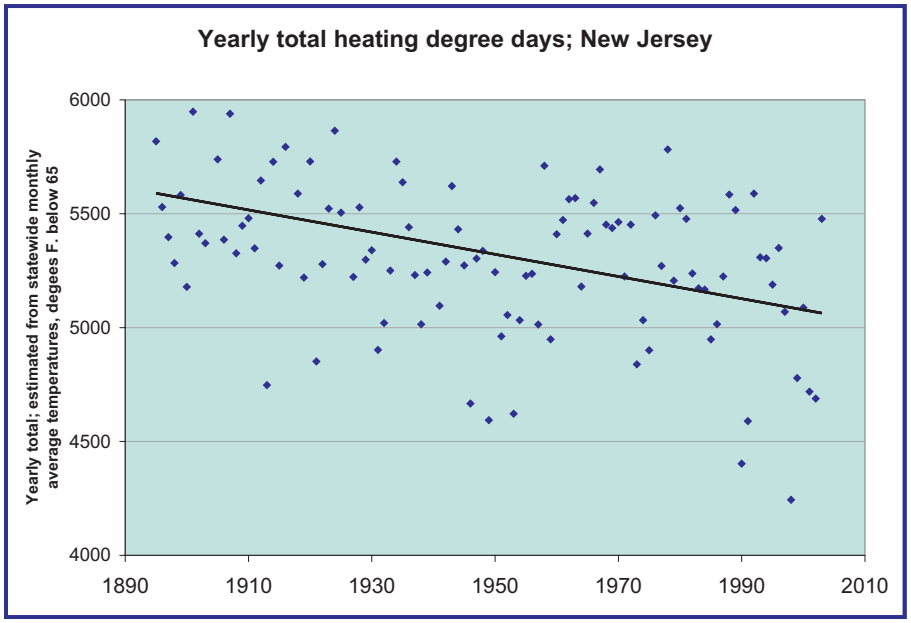






Yearly total heating and cooling degree days are usually calculated by adding up each day's total. However, they can be estimated with monthly average temperature days. Such estimation by the Department shows that, although there is much variation from year to year, the yearly average total of heating degree days has declined and the yearly average total of cooling degree days has increased over the period. See the figures "Yearly total cooling degree days.." and "Yearly total heating degree days.." below.

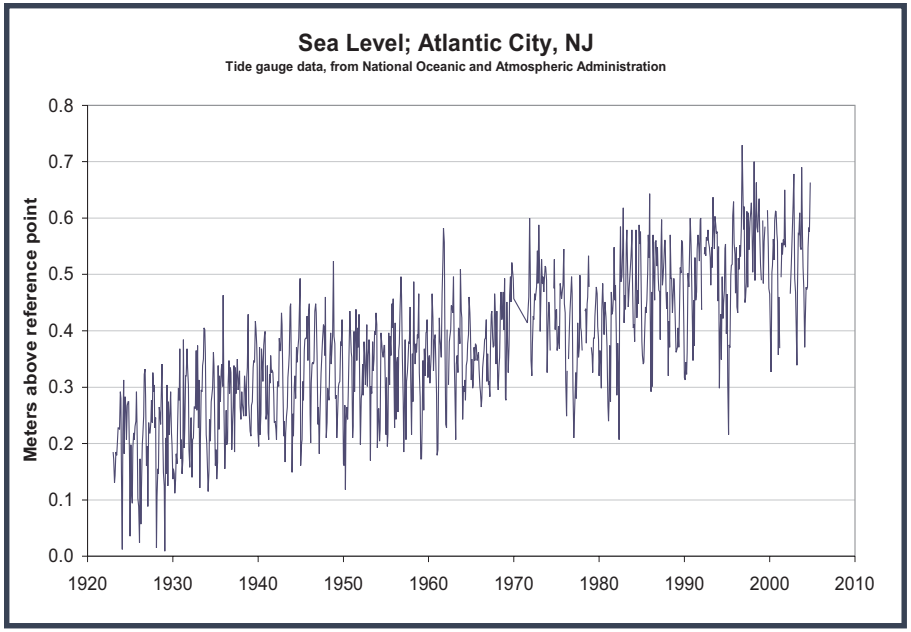


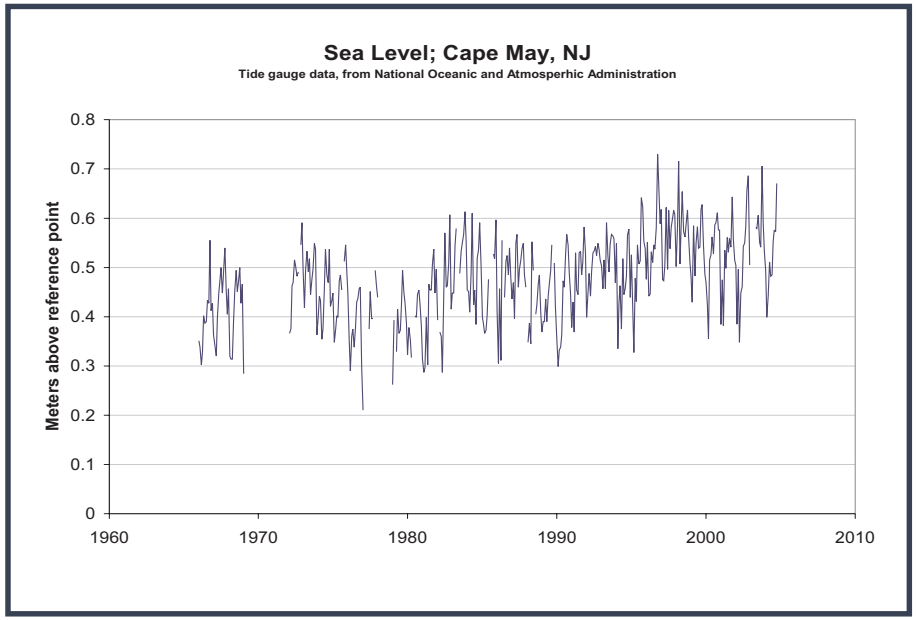


Status and Trends: Sea Level

As noted above, global average sea level rose by between 0.1 and 0.2 meters (4 and 8 inches) during the twentieth century, and the global mean sea level is likely to rise by an additional 0.09 to 0.88 meters (4 inches to 35 inches) by 2100. Tide gauge data made available by the National Oceanic and Atmospheric Administration (NOAA)[5] show that the sea level at the New Jersey coast sites of Atlantic City, Cape May, and Sandy Hook has risen at a rate of approximately 3 to 4 mm/y since recording began. Recent research completed for the Department shows that the preanthropogenic sea-level rise in New Jersey was approximately 2 mm/y, due to geological factors.[6] This suggests that the anthropogenic contribution to the recent higher rate of rise is approximately 1-2 mm/y, approximately one-half of the total observed rate of rise, which is in line with the IPCC estimate of the global rate. Some of the anthropogenic rise is believed due to land subsidence caused by groundwater withdrawal; this is believed to be especially significant at the Atlantic City site.

See the figures "Sea Level, Atlantic City, NJ", "Sea Level, Cape May, NJ", and "Sea Level, Sandy Hook, NJ" below.





Outlook and Implications

Rising temperatures

Rising ambient temperatures are expected to have direct and indirect impacts on human health and the environment in New Jersey. Direct human health impacts are likely to include increased heat stress, especially for vulnerable urban populations, such as the elderly and urban poor. Climate models predict an increase in the number of days per year with temperatures above 90° F in the New York City metro area, with a potentially significant impact on human health due to heat stress.[7] By the 2020s, climate change could result in an increase in summer heat-related mortality of 55% and a more than doubling in mortality by the 2050s.[8]

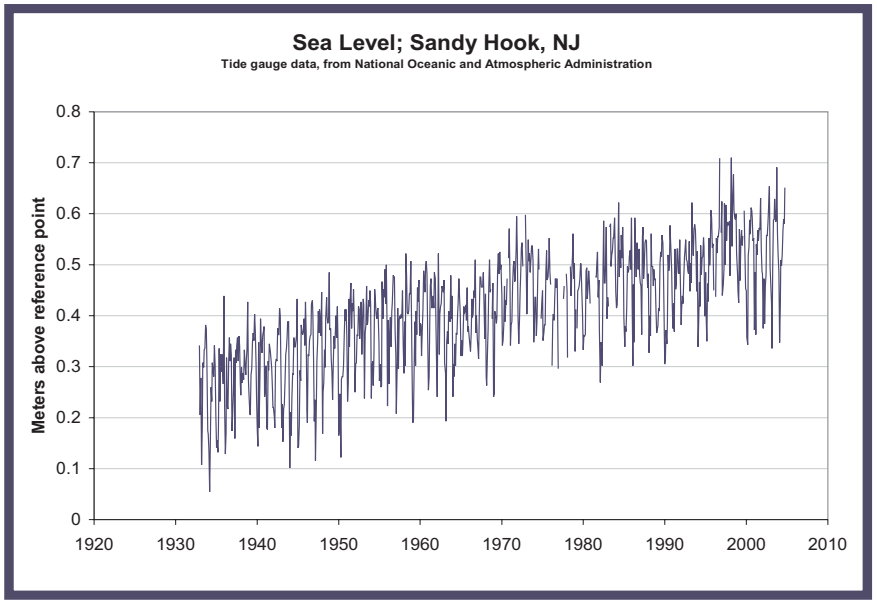
Other human health impacts are also likely. Rising temperatures are expected to exacerbate the formation of ground-level ozone, which will further challenge New Jersey attempts to meet national ambient air quality standards for protection of human health and welfare. In addition, ozone is itself a greenhouse gas. High temperatures will also enhance the secondary formation of fine particles, which also have health impacts.

Warmer temperatures, particularly in the winter season, could facilitate the northern spread of disease-carrying insects.

Natural ecosystems, water supply and agriculture are also likely to be affected by warmer temperatures and associated changes in the water cycle. Climate-related habitat loss could lead to extinction of some threatened species. Warmer temperatures are expected to lead to more intense rain events, since warm air holds more water vapor. However, warmer temperatures also are likely to lead to greater evaporation and transpiration of moisture, which could cause drier conditions in soils. The probable impacts on New Jersey are difficult to assess. Global temperature change may alter today's normal storm tracks, possibly leading to increased incidence of drought events in the State.

Rising seas

Sea level rise due to climate change is of major concern to New Jersey. New Jersey is especially vulnerable to significant impacts due to geologic subsidence, the topography of its coastline, current coastal erosion, and a high density of coastal development.[9]



A sea level rise in line with median IPCC projections would threaten the majority of New Jersey's coastline. The effects of sea level rise will be exacerbated in New Jersey since relative sea level rise in New Jersey will be greater than the global average due to coastline subsidence. Effects of rising sea level are magnified during storm events. Higher sea levels will increase the severity of storm-related flooding in coastal and bay areas. In addition to significant property losses, sea level rise will adversely impact coastal ecosystems and may threaten coastal fresh water supplies due to salt-water intrusion.[10]

Currently, responses to rising sea levels and increasing erosion along the NJ coast have been the construction of sea walls and bulkheads, raising land elevation with beach nourishment projects, and the building of jetties to capture sand. All of these approaches are expensive, and the costs can be expected to increase as sea level rises further. The additional impact of anticipated more intense storms and floods when coupled with higher sea levels will likely compound the growth in costs. (See the report, Beach Replenishment, in this Environmental Trends series.)

More Information

More information on climate change and its causes and effects, and on efforts to reduce greenhouse gas emissions in New Jersey, can be obtained from the Division of Science, Research, and Technology; Bureau of Sustainable Communities and Innovative Technologies. See http://www.state.nj.us/dep/dsr/bscit.htm. The U.S. Environmental Protection Agency also has a great deal information on climate change available. See http://yosemite.epa.gov/oar/globalwarming.nsf/content/index.html. New Jersey temperature and other climate data are available from the New Jersey State Climatologist; see http://climate.rutgers.edu/stateclim.

References

[1] Intergovernmental Panel on Climate Change (IPCC), 2001, Third Assessment Report of Working Group I, Climate Change 2001: The Scientific Basis.

[2] IPCC, 2001.

[3] Downloaded from http://climate.rutgers.edu/stateclim/data/njhisttemp.html 8/13/04

[4] So, for example, if a day's average temperature was 30° F, it would represent 65-30, or 35, heating degree days. If a day's average temperature was 75° F, it would represent 75-65, or 10, cooling degree days.

[5] Downloaded from http://co-ops.nos.noaa.gov/sltrends/sltrends.shtml, 11/18/04.

[6] Stanley, Alissa, Kenneth Miller, and Peter Sugarman, 2004, Holocene sea-level rise in New Jersey:
An Interim Report, DEP Grant Final Report, Submitted to New Jersey Department of Environmental Protection Division of Science, Research & Technology, September 15, 2004.

[7] Kinney et al., 2000, Climate Change and Public Health, 2000, U.S. Global Change Research Program, Climate Change and a Global City: An Assessment of the Metropolitan East Coast Region.

[8] New York Climate & Health Project, Assessing Potential Public Health and Air Quality Impacts of Changing Climate and Land Use, Columbia University, 2000.

[9] U.S. Department of State, 2002, U.S. Climate Action Report, p. 103, U.S. Department of State, Washington, DC.

[10] U.S. Global Change Research Program, 2000, Metropolitan East Coast Assessment of Impacts of Potential Climate Variability and Change, U.S. Global Change Research Program, Mid-Atlantic Assessment of Impacts of Potential Climate Variability and Change.